the ENERGY lab

R&D FACTS

Advanced Energy Systems

Turbine Thermal Management

The gas turbine is the workhorse of power generation, and technology advances to current land-based turbines are directly linked to our country's economic and energy security. Technical advancement for any type of gas turbine generally implies better performance, greater efficiency, and extended component life. From the standpoint of cycle efficiency and durability, this suggests that a continual goal for higher gas turbine-inlet-temperatures (TITs) with reduced coolant levels is desirable.

The realization of future high-efficiency, near-zero emission turbine power systems depends on the advancement of thermal protection of hot sections, such as first-stage vanes and blades, and control of secondary flows. Current technology for protecting such airfoils relies primarily on the combined effects of a thermal barrier coating (TBC) and convective cooling. However, state-of-the-art development in both TBC materials and cooling technologies is insufficient to meet the thermal-mechanical demands imposed by hot gas with elevated turbine-inlet-temperatures. This suggests that significant advances in turbine cooling effectiveness, as well as TBC performance and durability, are required. This research effort aims to significantly advance TBC material and aerothermal cooling technologies.

Turbine Thermal Management Research at NETL

The NETL-Regional University Alliance (NETL-RUA) Turbine Thermal Management team is taking an integrated, systematic approach to addressing advanced turbine needs. The primary objective of this research is to support the hydrogen turbine technology area in meeting the DOE advanced turbine development goal, which calls for a 3–5 percent increase in power island efficiency and a 30 percent power increase above the hydrogen-fueled combined cycle baseline.

Research projects utilize the extensive expertise and facilities readily available at NETL and participating universities. The research approach includes explorative studies based on scaled models and prototype coupon tests conducted under realistic pressurized, high-temperature turbine operating conditions.

Technical goals for NETL-RUA Turbine Thermal Management research include:

- Development of novel, manufacturable internal airfoil cooling technology concepts that achieve a cooling enhancement factor of approximately five.
- Development of advanced, manufacturable airfoil film cooling concepts that achieve a 50 percent reduction in required cooling flow.
- Design, construction, and operation of a world-class facility for testing new cooling improvement strategies for the turbine rotating blade platform.

CONTACTS

George Richards
Focus Area Lead
Energy System Dynamics
304-285-4458
george.richards@netl.doe.gov

Mary Anne Alvin
Division Director
Geosciences Director
412-386-5498
maryanne.alvin@netl.doe.gov

NETL-RUA PARTNERS

Pennsylvania State University

University of Pittsburgh

URS Corporation

Virginia Tech

NATIONAL ENERGY TECHNOLOGY LABORATORY

Albany, OR • Anchorage, AK • Morgantown, WV • Pittsburgh, PA • Sugar Land, TX

Website: www.netl.doe.gov

Customer Service: 1-800-553-7681

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- Development of advanced material system architectures that permit operation of turbine airfoils at temperatures approximately 50–100º C higher than current state-of-the-art components.

Impact and Benefits

Research results obtained through this project can directly benefit the U.S. power and utility turbine industry by improving product development that specifically meets DOE advanced turbine program goals. Turbine technology benefited by this research will lead to products with higher efficiency and reduced emissions. Higher efficiency implies alleviating dependence on foreign oil and improving preservation of domestic natural resources. Reduced emissions will not only yield better environmental conditions but will also decrease costs for pollution controls, including carbon capture and sequestration. These factors combined will eventually lead to greater energy security and economy.